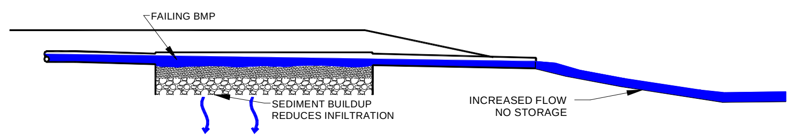
Design Criteria

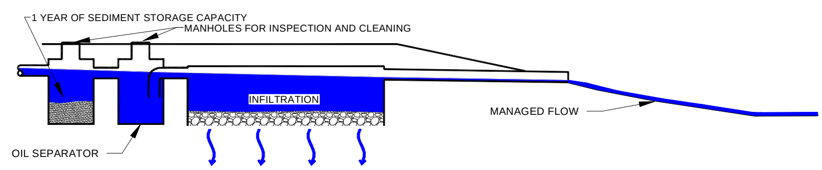
Comprehensive Environmental Inc.

DESIGN GUIDELINES AND CRITERIA FOR STORMWATER MANAGEMENT

NOVEMBER 2003



BMP WITHOUT PRE-TREATMENT



BMP WITH PRE-TREATMENT

For communities, states, engineers and others who are trying to minimize the impacts of stormwater management systems on the end users.

Acknowledgements

Comprehensive Environmental Inc. would like to thank the Town of Merrimack, New Hampshire Planning Board, Community Development Department staff and Department of Public Works staff for their commitment to developing a better process for addressing the regulatory components of Phase II Stormwater Regulations. These criteria were developed in part as a regulatory compliance effort for the Town of Merrimack, and included several meetings and extensive time for review of concepts and issues. We would also like to acknowledge the cooperation and input received from the following individuals and departments in reviewing the criteria and providing input.

Nelson Disco, Chairman, and members of the Town of Merrimack Planning Board
Jay Minkarah, Director, Department of Community Development, Merrimack, NH
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Donald Ware, P.E., Vice President, Pennichuck Water Works, Nashua, New Hampshire
Paul Susca, New Hampshire Department of Environmental Services
Eric Williams, New Hampshire Department of Environmental Services
Virginia Scarlet, Massachusetts Department of Environmental Protection

Note that these are generic criteria and site specific engineering is always required for proper application of these criteria. CEI cannot be held responsible for errors or omissions that could occur in applying these criteria to specific sites.

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Introduction

The purpose of these criteria is to address some problems that CEI has identified as commonly occurring design issues in stormwater management, particularly in areas where snow and road sanding are common. The firm set out to develop in-house design criteria in 1999 and 2000 as we began to identify many problems in stormwater Best Management Practice (BMP) designs as part of an intensive, on-the-ground watershed review of a small water supply watershed. Most of the BMPs were less than 5 or 10 years old, but had already failed. Detention basins were full and overflowing, underground structures and treatment units were full, and many designs were not working or had never worked adequately.

Although we expected to see maintenance failures, and we did, we also began to realize that some of the designs were nearly impossible to maintain. Because we were actively doing our own designs, we wanted to make sure that these would be something we would be proud of many years down the road. Our initial in-house criteria were completed in 2001. We then began adding criteria as a result of problems we found in designs that we were reviewing as part of our plan review services for municipalities. We also began refining these criteria as a part of Phase II work with communities such as Scituate, Walpole and Arlington, Massachusetts. These design criteria address many of the problems we found during those onsite and plan review projects.

These in-house criteria were then further refined as part of a public process with the Town of Merrimack, New Hampshire's Planning Board. Explanatory drawings were added and regulations referenced to make the criteria more user friendly for laypeople. Merrimack incorporated the criteria into a stormwater management manual of their own. Finally, by request, we decided to publish these criteria so that they would be available to everyone interested in improved performance and reduced maintenance burden of stormwater facilities.

Note that there are other maintenance and review criteria, but only features that can be addressed as part of the design are described herein. We have also not covered some of the standard treatment criteria such as sizing for treatment volumes in this document as they are handled adequately in other documents, which are referenced in the appendices.

Background of Stormwater Treatment

Current technologies and designs provide more effective stormwater treatment, recharge and sometimes less flooding than older systems. However, there are a number of problems with these traditional treatment designs that still follow the original engineered model of collection, concentration and off-site conveyance with an attempt to handle large, newly developed peak flow at the end of a pipe. Methods such as detention basins and under parking lot infiltration units have been designed to perform many of the beneficial services that would occur naturally if there were no human development of the area, and as such are an improvement over direct piping to the nearest water course or municipal system, but they could still be significantly improved.

To control the problem created by piped drainage, many systems have been created to hold the concentrated stormwater back and release it slowly. For example, detention ponds were designed that could force stormwater to pool temporarily, slowing down the flow and reducing the surge of stormwater that might otherwise overwhelm an area further downstream. This strategy worked very well, and had the added benefits of providing some sediment and contaminant removal. Unfortunately, detention ponds are very large, and the economic value of the surface area on a parcel has inhibited the use of detention ponds to some degree. Detention ponds also require heavy equipment to maintain once the sediment deposits reduce the ponds capacity.

There are also some traditional treatment systems that have been developed to remove large percentages of sediment and associated contaminants. Proprietary systems that use vortex type technology are extremely efficient, require very little space, and the only surface area required is a manhole for maintenance. This allows them to be placed beneath parking lots and no surface area needs to be devoted to stormwater problems. The problem with these systems is that they do not promote flood control and they may require frequent maintenance if undersized. The maintenance is necessary because they are so efficient. Sediments quickly build up within the tank, and the system will stop working altogether if water just passes through it due to a lack of storage space. The fact that these units are so well concealed and so efficient means that it is easy for a property owner to neglect the required maintenance, allow the system to fail, and not realize it.

Some traditional treatment systems now help recharge groundwater levels by infiltrating stormwater into the ground. This process provides excellent contaminant removal from the water. This is due in part to the fact that sediment and contaminants adsorb to the soil particles or are filtered out by the soil matrix itself. This coarse filtering occurs because they are too large to fit through the pores between the particles or the water is slowed down enough that it can no longer hold them in suspension. The soil matrix prevents many contaminants from passing through, while the filtered water continues to infiltrate. Leaching fields like those used for septic tanks are used to distribute stormwater throughout a large soil area by directing water through perforated pipes.

Filtering the stormwater with soils has many benefits, but as more sediment is filtered out of the stormwater, it clogs the pores of the soil and the water will begin to back up. Renovation of this type of system is difficult, expensive and mostly ignored. But if this sort of infiltration device is paired with a pretreatment device such as a proprietary system to remove the majority of the sediment first, complete failure is less likely (if the pretreatment device is maintained). Unfortunately, the proprietary system may fail due to neglect, and then the rest of the infiltration system will fail shortly after. This failure may also avoid detection due to the overflow outlet that usually prevents these systems from backing up and flooding the parking lot. Stormwater can then flow through the useless structures that are tucked out of sight and mind, and be discharged into the nearest water body, rendering the entire system ineffective.

Traditional methods of handling stormwater have been designed with the intent of collecting it and carrying it off a site to a nearby surface water, sometimes using basins to slowly release it. However, these methods often do not adequately address water quality and the recharge of underlying groundwater aquifers or the downstream effects of the collected water. Pollutants carried by stormwater have degraded wetlands, rivers, streams and ponds, polluting surface water supplies and vegetative and wildlife habitats. Groundwater drinking water supplies have also been reduced, as water is collected from impervious ground surfaces and piped directly to surface waters, rather than infiltrating into the ground. The results of these impacts are profound. Reductions in drinking water supplies and drinking water quality have resulted in water restrictions and increased water treatment. Pollution of natural habitat has impacted fishing and other recreational opportunities and our natural heritage. All of these impacts ultimately result in increased costs to communities.

Regulatory Initiative

In an effort to more effectively address stormwater quality, the EPA expanded the National Pollutant Discharge Elimination System (NPDES) permitting program, publishing a final ruling for Phase II in the December 8, 1999 Federal Register. The Phase II regulations apply to certain small municipal storm sewer systems and construction sites involving one to five acres of land disturbance. Part of the requirements under the Phase II program is for local communities to adopt regulatory controls to improve the quality of stormwater runoff. Adoption of these criteria should satisfy the post development controls called for in Phase II in most cases.

Permit Process

Under the new Phase II Stormwater regulations, all subject[1] communities must take responsibility for inspecting stormwater controls on private property. If the owner refuses to maintain a facility or structure that is in need of maintenance, then the municipality must either place a lien on their property until they do, or perform the maintenance themselves and backcharge the owner.

To address part of this requirement, CEI recommends that developers commit to an Operation and Maintenance Plan that includes specific sizing assumptions for maintenance volumes as well as cleanout frequencies and other information. This plan should be filed and recorded with the site plan along with an annual report to the town. If the O&M plan and annual report contain a receipt for the required maintenance, this may save the community considerable numbers of inspections. However, it needs to be set up as part of the plan review process. See also CEI's O&M Template for Stormwater BMPs.

Stormwater Design Criteria

All of the design details and recommendations are for explanation and illustration of key concepts. Not all possible designs are shown, and site-specific professional engineering design and judgment is always required. Each criteria is described for background; objectives and goals; minimum standards; regulatory reference (to where it is required if applicable) and engineering criteria. It is important to note that requirements may vary by state and where the state's criteria are more stringent than CEI's criteria, then the state criteria should be used instead. The criteria described herein include:

1. Peak Discharge
2. Maintenance Volumes
3. Pre-Treatment
4. Infiltration
5. Runoff Prevention
6. Parking
7. Site Clearing

[1] Municipalities with a population of less than 100,000 that are located in or near an urbanized area are subject to the new Phase II Stormwater Regulations.

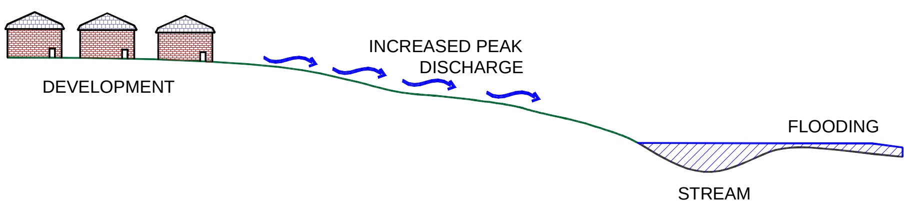
Design Criteria No. 1. Peak Discharge Rates

Introduction

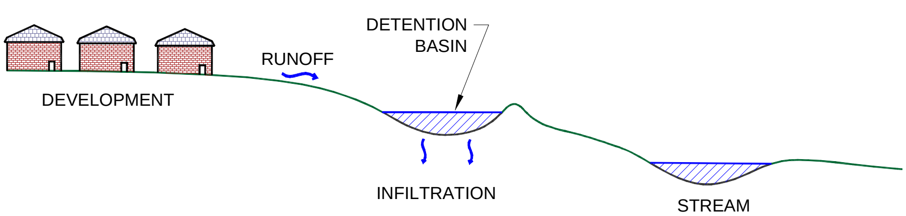
Maintaining the pre-existing peak discharge rates from developed sites has been an accepted practice to reduce potential downstream flooding. Typical methods to control peak discharge involve detention/retention basins. If designed properly, these basins can provide additional benefits such as removal of sediment and pollutants from stormwater and infiltration to the groundwater supply. As shown in the example below, detention basins designed to control peak discharge by restricting the diameter of the outflow will permit smaller storms to pass through the system without being treated. Adding a simple stand pipe to the design will provide retention and treatment of larger storms and promote infiltration. While stormwater quality BMPs are required to treat up to the 2-year storm, the stormwater management system is required to provide attenuation of the difference between the pre- and post-development peak discharges for the 10-, 25- and 100-year storms to control flooding.

Objectives and Goals

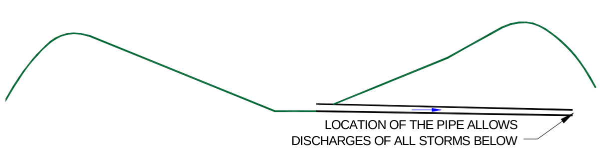
- ❑ Minimize risks of downstream flooding
- ❑ Improve water quality by providing retention/detention
- ❑ Promote infiltration and groundwater recharge



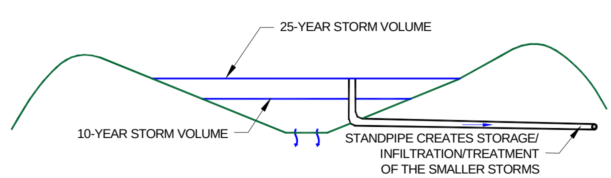
WITHOUT EFFECTIVE PEAK DISCHARGE CONTROL



EFFECTIVE PEAK DISCHARGE CONTROL



INEFFECTIVE PEAK DISCHARGE CONTROL



EFFECTIVE PEAK DISCHARGE CONTROL

Minimum Standards

The following standards should be followed to control peak discharge rates and improve the overall effectiveness of the BMPs. These are minimum design standards. Factors such as site conditions and watershed characteristics should be taken into consideration and may warrant increased standards.

- ❑ The post development peak discharge rate is equal to or less than the pre-development peak discharge rate (based on a 2-year, 10-year, 25-year, and 100-year, 24-hour storm), ***and***
- ❑ The applicant has accounted for all run-on and run-off (including off-site impacts) in both pre- and post-development conditions, ***and***
- ❑ Curve numbers used to determine pre- and post-development discharge according to characteristics of the land are based on Town-approved curve numbers, ***and***
- ❑ The applicant has prepared hydrographs for pre- and post-development conditions.

Regulatory Reference

Standards for peak discharge rates have been developed from industry accepted standards as documented in publications by EPA's Post-Construction Storm Water Management in New Development and Redevelopment Stormwater Program Fact Sheets in National Menu for BMP Practices, 2002 and in EPA's National Management Measures for Stormwater, 2002.

Engineering Criteria

- ❑ Use Curve Number (CN) values as provided in Table 1 to calculate stormwater runoff rates for pre/post construction ground surface conditions.
- ❑ Use TR-55, TR-20 or the Rational Method to develop hydrographs and peak flow rates for the proposed development site. Make sure all areas are accounted for in the pre/post runoff calculations. The total tributary area that contributes flow from the proposed site must be included even if a portion does not contribute flow to the BMP. The objective is for the development's storm drain design to account for total runoff leaving the site.

Table 1. Modified CN Values for the SCS Methods (TR-20, TR-55)

	Hydrologic Soil Group			
Pre-Construction Runoff Curve Number (CN Values)	A	B	C	D
Open space such as lawns, parks, and cemeteries[2]	68	79	86	89
Woods and forest[3, 4]	30	55	70	77
Impervious areas such as paved parking lots, driveways and roofs	98	98	98	98
Gravel roads (processed, dense graded)	76	85	89	91
Dirt roads	72	82	87	89
Newly graded pervious areas (no vegetation)	77	86	91	94
Post-Construction *Runoff-Curve Number (CN Value)*	A	B	C	D
Open space such as lawns, parks, and cemeteries[2]	68	79	86	89
Woods and forest that is selectively cleared[3]	43	65	76	82
Impervious areas such as paved parking lots, driveways and roofs	98	98	98	98
Gravel roads (processed, dense graded)	76	85	89	91
Dirt roads	72	82	87	89
Newly graded pervious areas (no vegetation)	77	86	91	94

Source: TR-55, 1986

Notes:

1. *The runoff curve numbers are for use in calculating runoff with TR-55 or other approved models.*
2. *The open space CN values for lawns, parks, and cemeteries assumes a "poor" condition for grass cover since the post-construction amount of grass cover cannot be predicted or guaranteed.*
3. *The pre-construction CN value for woods and forest is based on a "good" condition where the woods are undisturbed and brush adequately covers the soil. The post-construction CN value for woods and forest is based on a "fair" condition if any selective cutting is conducted since the soils typically become compacted due to the equipment used to remove the large white pines and there may be post-cutting wind damage to the remaining unsupported canopy. If the applicant can demonstrate that no disturbance will occur during construction, then the pre-construction CN value for woods may be used for the post-construction runoff calculations. A note should be placed on the plan indicating where selective cutting will occur.*
4. *Any site that was wooded within the last five years must be considered undisturbed woods for all pre-construction runoff conditions, regardless of clearing or cutting activities that may have occurred on the site during that pre-application period. The purpose is to discourage pre-submittal clearing that sometimes results in undersized stormwater facilities that the town could have to maintain under new federal stormwater requirements.*

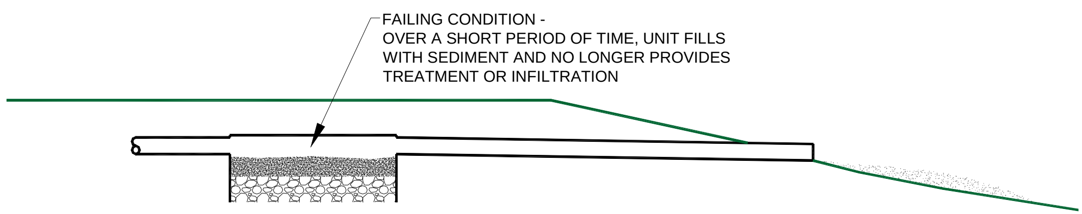
Design Criteria No. 2. Treatment & Maintenance Volumes

Introduction

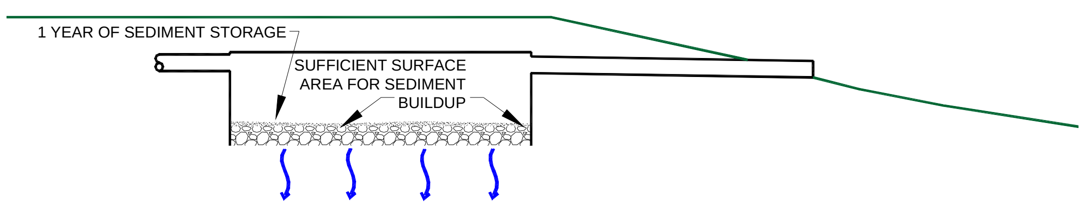
It is crucial that stormwater treatment devices are sized to hold sediment accumulated over a one-year period or greater. It is often not practical to perform required maintenance more than once a year. For this reason, BMPs that are not sized to accommodate a minimum of one year's sediment will likely fill with sediment, decreasing the effectiveness of the device to the point of failure. Sediment passes through the device, and stormwater receives little or no treatment. When designing a stormwater control device, the sizing calculations must not include or account for any exfiltration of the stormwater leaving the structure and percolating into the soils during the storm event. The exfiltration capacity is frequently reduced following years of sedimentation and infrequent maintenance. It is imperative that the first inch of runoff be handled effectively, as most of the pollutant loading occurs in this portion of stormwater. Adequate sizing of BMPs will decrease failure rates and improve the overall effectiveness of the stormwater treatment device.

Objectives and Goals

- ❑ Increase volume of stormwater treated
- ❑ Reduce maintenance frequency and costs
- ❑ Reduce BMP failure, therefore improving water quality
- ❑ Decrease risk of resuspending sediment
- ❑ Increase pollutant removal efficiency
- ❑ Increase groundwater resources



UNDERSIZED BMP



CORRECTLY SIZED BMP

Minimum Standards

The following standards should be followed to provide the appropriate sizing for BMPs. Sediment and clogging decreases exfiltration rates making it important to not overestimate this parameter.

- ❑ Initial exfiltration during the design storm shall not be accounted for during the unit/device sizing, with the exception of roof runoff devices, which may account for exfiltration in sizing calculations.
- ❑ All units/devices shall be designed to drain within 48 hours from the end of the storm.
- ❑ Underground Units shall be designed to treat and store the 2-year storm and infiltrate the 1-inch storm. Units must hold 1-year's worth of sediment debris.
- ❑ Aboveground Vegetated Units shall be designed to treat and store the 2-year storm and infiltrate the 1-inch storm. Units must hold 6-month's worth of sediment/debris.
- ❑ Roof Runoff Units shall be designed to store the 2-year storm and shall have gutter screens or other pre-treatment device.

Regulatory Reference

Proper sizing of infiltration systems will reduce maintenance frequency and associated cost, increase the rate of infiltration and amount of stormwater treated, ensure longer life of the devices and is good engineering practice. The EPA Phase II ruling (12/8/99 Federal Register, page 68760) calls for communities "to ensure adequate long-term operation and maintenance of the BMPs" and recommends a program to do so. It is in the Town's best interest to minimize the maintenance burden of each project.

Engineering Criteria

- ❑ When designing forebays, a rule of thumb for proper sizing is that the system should be capable of handling volumes of at least 0.1 inch/acre.
- ❑ The system should be capable of treating and storing a two year storm unless state or local regulations specify a larger storm.
- ❑ A sediment marker should be provided to enable the inspectors to get an accurate and consistent depth of sediment under the current conditions.
- ❑ To control bank erosion and maintain accessibility, side slopes should be designed with a slope less than or equal to a 3:1 ratio.
- ❑ To prevent scouring and resuspension of sediment, the system should be designed to prevent flow velocities from exceeding 2.5 feet per second (ft/s).
- ❑ The Universal Soil Loss Equation (USLE) should be used to calculate sediment deposits that would occur from pervious areas adjacent to the BMP.
- ❑ Sand deposits from winter storm applications should be accounted for when designing a pre-treatment system. The design should be capable of holding a minimum of one-year's worth of sediment. Sediment loads should be calculated using a sand application rate of 1000 lbs/acre for sanding of parking areas and access drives, a sand density of 90 lbs per cubic foot and assuming a minimum frequency of ten sandings per year. To obtain an annual sediment volume, perform the following calculation:

$$\text{Area to be sanded (acres)} \times 1000\ \frac{\text{pounds}}{\text{Acre-storm}} \div 90\ \frac{\text{pounds}}{\text{ft}^3} \times 10\ \frac{\text{storms}}{\text{year}} = \frac{\text{cubic feet of}}{\text{sediment/yr}}$$

Sanding rates and numbers of storms may need to be adjusted downward for southern New England and upward for northern New England.

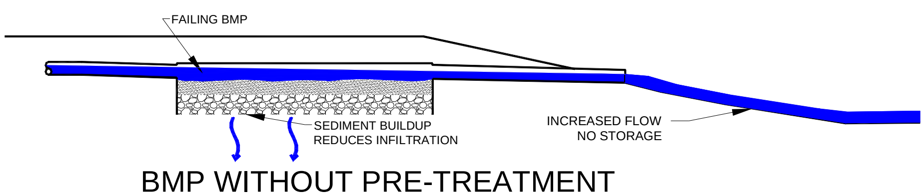
Design Criteria No. 3. Pretreatment

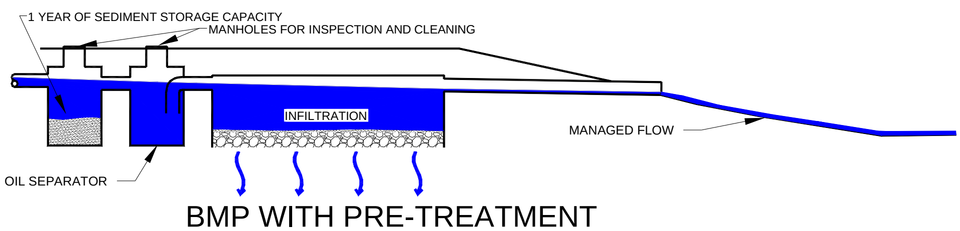
Introduction

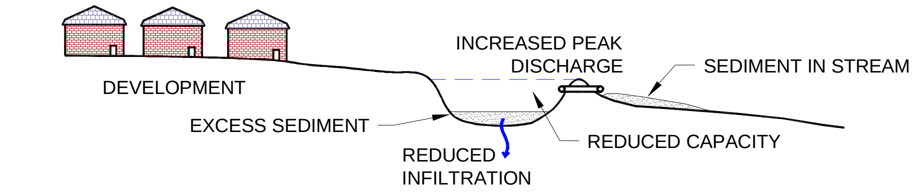
To prevent premature failure, it is crucial that the design of stormwater treatment devices relying on infiltration include a pre-treatment device or method that will trap sand and sediments before they clog the treatment mechanism. Infiltration of stormwater from the treatment device into underlying soils and eventually groundwater aquifers is an important beneficial component of the device. Pre-treatment basins must be designed and located to be easily inspected and accessible to facilitate maintenance. Pre-treatment devices must also be sized to accommodate a minimum of one-year's worth of sediment and debris.

Objectives and Goals

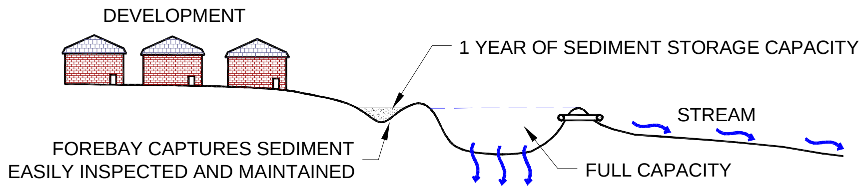
- ❑ Decrease risk of re-suspending sediment
- ❑ Increase pollutant removal efficiency
- ❑ Reduce maintenance frequency
- ❑ Reduce BMP failure, therefore improving water quality







WITHOUT PRE-TREATMENT



WITH PRE-TREATMENT

Minimum Design Standards

The following standards should be followed to ensure that the device will permit sufficient treatment to treat stormwater and allow for a reasonable required maintenance frequency for the BMP.

- ❑ Pre-treatment devices are provided for each BMP, ***and***
- ❑ Pre-treatment devices are designed to accommodate a minimum of one-year's worth of sediment, ***and***
- ❑ Pre-treatment devices are designed to capture anticipated pollutants, such as grease and oil, ***and***
- ❑ Pre-treatment devices are designed and located to be easily accessible to facilitate inspection and maintenance.

Regulatory Reference

Pre-treatment devices will reduce maintenance frequency and associated cost, increase the rate of infiltration and amount of stormwater treated, ensure longer life of the devices and is good engineering practice. The Town will become responsible for ensuring adequate long-term operation and maintenance of BMPs (12/8/99 Federal Register, page 68759, 68760). Requiring pre-treatment devices as part of the BMP design is not only in compliance with the Town's responsibility under the Phase II ruling, but will reduce the financial and logistical burden on the Town.

Engineering Criteria

See criteria for Treatment and Maintenance Volumes.

Design Criteria No. 4. Use Infiltration

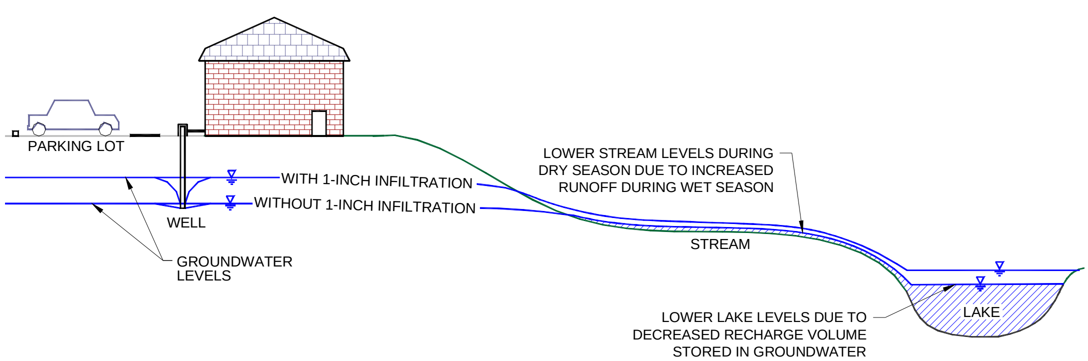
Introduction

Infiltration is the process whereby stormwater runoff percolates into the ground. In addition to contributing to groundwater supplies and recharging aquifers, the infiltration process naturally filters pollutants from the stormwater, as it passes through the soil. Groundwater is held within the water table and released slowly, ensuring a supply of water to drinking water wells (public and private), wetlands, watercourses, and water bodies during dry periods. Many of these aquifers and ecosystems depend on groundwater for a year-round supply of water. The example below illustrates the impacts to local water resources from reduced groundwater supply, due to increased stormwater runoff and reduced infiltration. Stormwater management design should incorporate infiltration wherever possible to restore and enhance the hydrologic cycle.

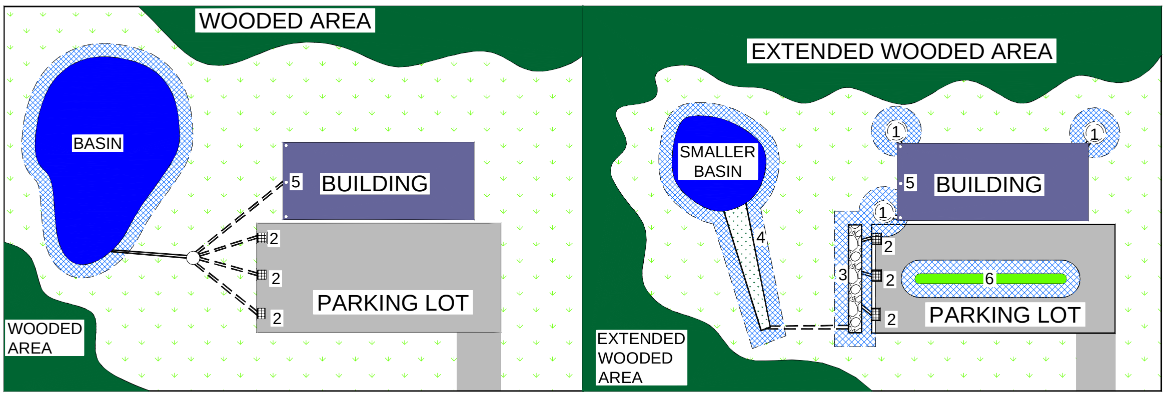
Using a greater number of smaller devices throughout the site (dispersion) is more effective than relying on a single device. In the example on the next page, three times the infiltration area surrounding the treatment devices (hatched area surrounding the devices) is available using dispersed units versus one single unit (each example has the same amount of total surface area within the devices). Capturing and retaining the first inch of a storm on-site will treat most of the pollutants in the stormwater and will provide valuable groundwater aquifer recharge. Additional infiltration will benefit groundwater supplies and counteract the lost groundwater recharge associated with past development practices. Compaction of soils should be minimized as much as possible and disturbed soils should be tilled to improve infiltration. Groundwater is a significant resource, contributing to drinking water supplies, consistent streamflow, wildlife ecosystems, and recreation opportunities. Infiltration is a cost-effective method to not only protect but enhance this resource.

Objectives and Goals

- ❑ Promote aquifer recharge
- ❑ Decrease runoff volumes and risks of flooding
- ❑ Remove pollutants



Key: **1. Drywell** **2. Deep Sump Catch Basin** **3. Infiltration Trench**
4. Vegetated Swale **5. Roof Leaders** **6. Bioretention Median**



POOR DESIGN

- One large basin
- Less infiltration potential
- More site disturbance

GOOD DESIGN

- Deep sumps for pretreatment
- Variety of smaller, dispersed units
- Greater infiltration potential
- Less site disturbance

Minimum Standards

The following standards should be followed to ensure that the maximum amount of precipitation is infiltrated on-site. It is crucial to design BMPs with the correct capacities so that they will function as effectively as intended.

- ❑ All storms up to 1-inch must be captured and infiltrated on-site. The volume of water to be infiltrated can be calculated using the following equation:

  Infiltration required (ft^3) = impervious surfaces (ft^2) X 1.0 (inch) / 12 (inches per foot)

  (Note: 12 is a conversion factor)

- ❑ A variety of BMPs are used, dispersed throughout the site, to provide additional infiltration of stormwater runoff.

- ❑ Soils under BMPs such as those containing crushed stone and wherever else appropriate shall be scarified or tilled to improve infiltration.

Regulatory Reference

The EPA notes that natural infiltration is lost during development and recommends infiltration to restore water balance where possible (12/8/99 Federal Register pages 68725, 68759, 68760). See also “Managing Stormwater As A Valuable Resource”, NHDES, September 2001.

Engineering Criteria

- ❑ Infiltration BMPs should be designed to store 1 inch of runoff over an impervious surface, regardless of the soil type.

- ❑ The infiltration rate calculations of the system must be based on data collected in the field.

- Typical stone of 1.5 to 3 inches should be used to line the bottom of the infiltration bed.
- Storage volume must be based on the void space of the underlying stone and soils.
- Filter fabric should be used to line the sides of the BMP and placed on top of the stone to prevent voids from clogging with sand and sediment.
- An observation well must be installed to survey the efficiency of the infiltration system. Acceptable infiltration rates can be determined by observing the groundwater level in the infiltration bed after storm events.
- The infiltration system must be capable of achieving a minimum infiltration rate of 0.5 inches /hr. The system must also be capable of infiltrating all stormwater from an event within a 48-hour period.
- A two-foot separation to groundwater must be maintained from the bottom of the infiltration bed to prevent the leaching system from becoming saturated and provide adequate infiltration capacity in the soil.
- Bypasses should only be used if the absence of a bypass will result in a public health threat or safety issue. Parking lot flooding is not typically a health and safety threat. If bypasses must be used, they should be designed to make parties responsible for maintenance aware of system failure. The discharge from the bypass should be designed such that the failing system can not go unnoticed.
- Infiltration systems should not be located within a suitable distance from a septic system or private well, depending on local hydrologic conditions and the size of the infiltration system.
- Infiltration systems should not be located within the controlled radius of a public water supply depending on the size of the infiltration and the potential quality of the infiltrated water.

Design Criteria No. 5. Prevent Runoff

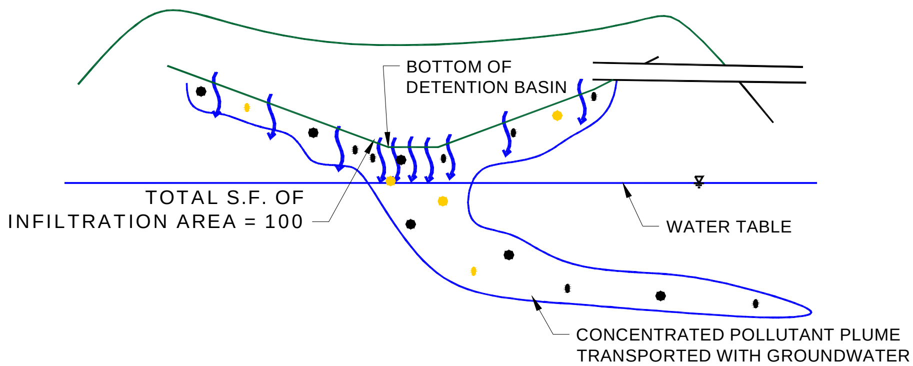
Introduction

Since volume of flow is often limiting to treatment options and effectiveness, it is important to reduce the volume as much as possible by preventing runoff and infiltrating upstream as much as possible. For example, using drywells to infiltrate roof runoff is a great method to prevent more street runoff that will become contaminated and add to the volume to be treated. It also helps in reestablishing a more natural hydrologic cycle.

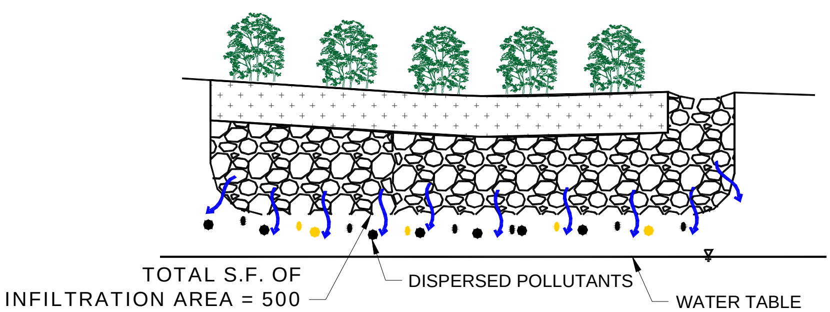
Another example is shown below for a large detention basin. Research has shown that major infiltration sites such as these can pollute groundwater. Conversely small sites like rain gardens and swales that only handle a small area use the soil matrix for treatment and are quite effective. These smaller sites have not been found to create groundwater pollution but instead the microorganisms in the soil rapidly break down pollutants and produce clean groundwater. Since so many areas have declining groundwater due to imperviousness (by prevention of recharge), this can help reestablish the natural hydrologic cycle and produce clean baseflow for stream discharge. *The City of Nashua, New Hampshire Alternative Stormwater Management Methods, Part 1 – Planning and Guidance* and *Part 2 – Designs and Specifications* gives guidance on preventing runoff through low impact designs in northern climates with a number of examples and redesigns. Using a combination of alternative designs will result in a more effective stormwater management design and may also provide more flexibility in site design by allowing a wider variety for locations of devices.

Objectives and Goals

- ❑ Improve stormwater quality
- ❑ Increase infiltration
- ❑ Provide flexibility for applicants

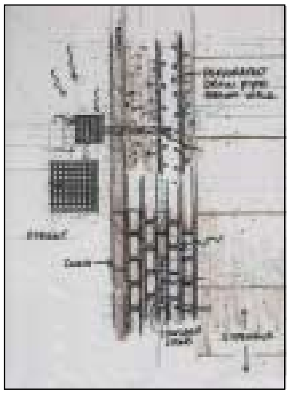


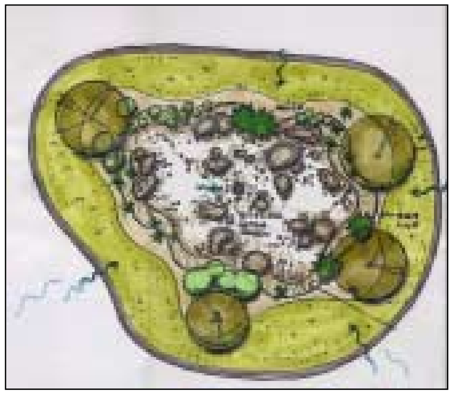
A. INADEQUATE DESIGN

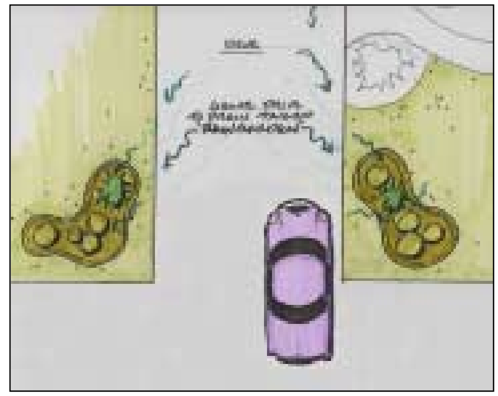


B. ADEQUATE DESIGN

Examples of Alternative Designs







Curbside Treatment **Bioretention Basins** **Raingardens for street runoff**

Minimum Standards

The following standards should be followed to ensure that alternative designs are appropriately designed and will be effective in stormwater treatment.

- ❑ The proposed units/devices are included in "*The City of Nashua, Alternative Stormwater Management Methods*".
- ❑ If the proposed units/devices are not listed in the above referenced publication, the applicant shall demonstrate how the proposed control(s) will protect water quality and provide groundwater recharge. The applicant must provide design calculations and other backup materials as necessary.
- ❑ The BMPs are planted with low maintenance plant material (native plant material preferred). Water requirements are minimized. The use of fertilizers and pesticides within the footprint of the BMPs is discouraged, however, all sites shall be loamed and landscaped in accordance with the Town's Landscaping Guidelines.

Reference

Alternative site designs provide additional flexibility for applicants in the site design process and often increase the effectiveness of the treatment, as individual devices are designed for particular characteristics of the site or the type of stormwater to be treated. Alternative designs are promoted by the U.S. Environmental Protection Agency and are continually being studied, improved and expanded by various organizations throughout the U.S. Many of the device concepts discussed in these fact sheets are included in the list of Best Management Practices recommended by the EPA (www.cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm) or in recent documents from EPA such as National Management Measures to Control Nonpoint Source Pollution from Urban Areas, Draft, July 2001 and National BMP Menu, 2001.

Engineering Criteria

None specific. See guidance listed in No. 5 above.

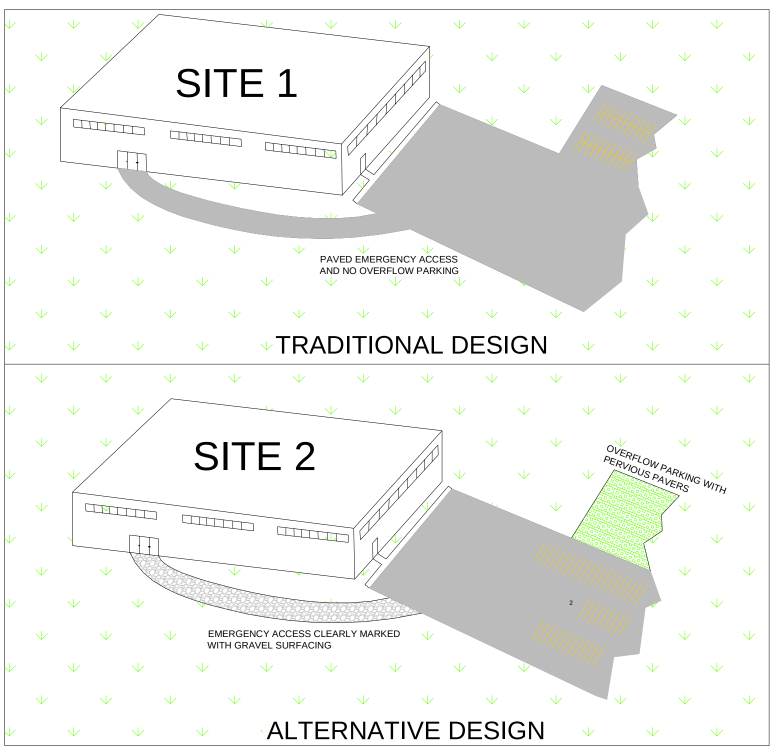
Design Criteria No. 6. Parking

Introduction

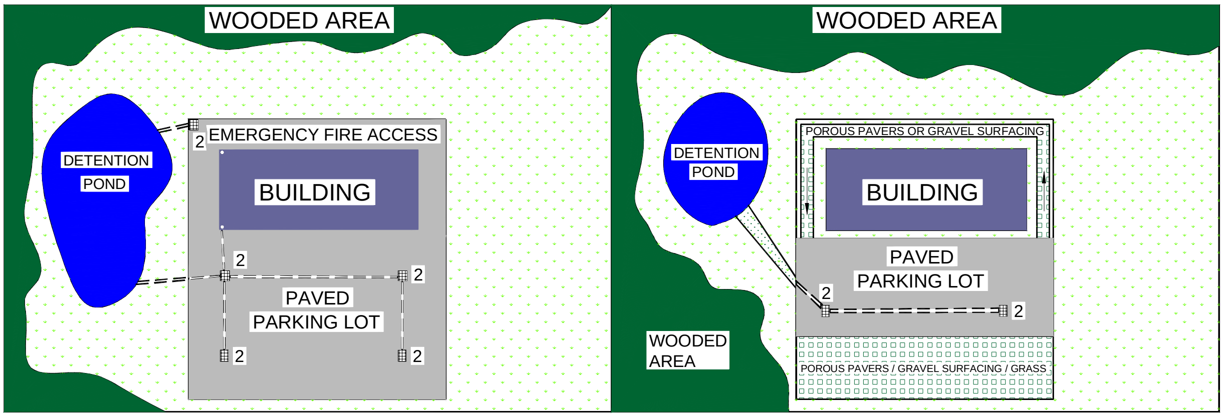
Impervious areas such as paved parking lots and emergency access drives create increased stormwater runoff. Often, parking lots of commercial uses are not fully utilized throughout the entire year. Building only the required parking and providing overflow parking that utilizes permeable parking surfaces will decrease the amount of impervious surfaces on the site and consequently decrease the amount of stormwater runoff generated from the development. The parking would be made available during peak periods such as the holiday shopping season but could be used as a landscaping design element, such as a wildflower meadow during summer months.

Objectives and Goals

- ❑ Provide adequate parking for business needs
- ❑ Decrease amounts of impervious surfaces for overflow, emergency access and future phases
- ❑ Promote infiltration and groundwater recharge
- ❑ Decrease runoff rates and volumes



Key: 2 = catch basin



TRADITIONAL DESIGN PERVIOUS OVERFLOW PARKING

Minimum Standards

The following standards should be followed to promote infiltration and reduce overall stormwater volumes. This will also reduce sizing costs associated with large volumes of stormwater runoff.

- ❑ Area for parking is available for the minimum number of required spaces.
- ❑ Average parking demand has been calculated for the use, and primary parking areas are proposed to accommodate the average parking demand.
- ❑ Additional/overflow parking spaces are proposed, and these have a pervious surface (i.e. grass, pervious pavers, etc.).
- ❑ Infrequently used emergency accesses or routes use pervious surfaces as above with clear signage to clearly identify their locations to emergency vehicles.

Regulatory Reference

The Center for Watershed Protection considers parking lots to be one of the most damaging land uses in the urban landscape (2000). The Institute of Transportation Engineers (ITE) and the Urban Land Institute (ULI) are actively studying ways to reduce the number of parking spaces required for various land uses. Increasing numbers of communities are addressing the issue using site design guidelines. The minimization of impervious surfaces associated with development is promoted by the EPA as a method to comply with the requirements of the Clean Water Act (12/8/99 Federal Register, page 68759, 68760).

Engineering Criteria

None specific. See guidance listed in No. 5 above.

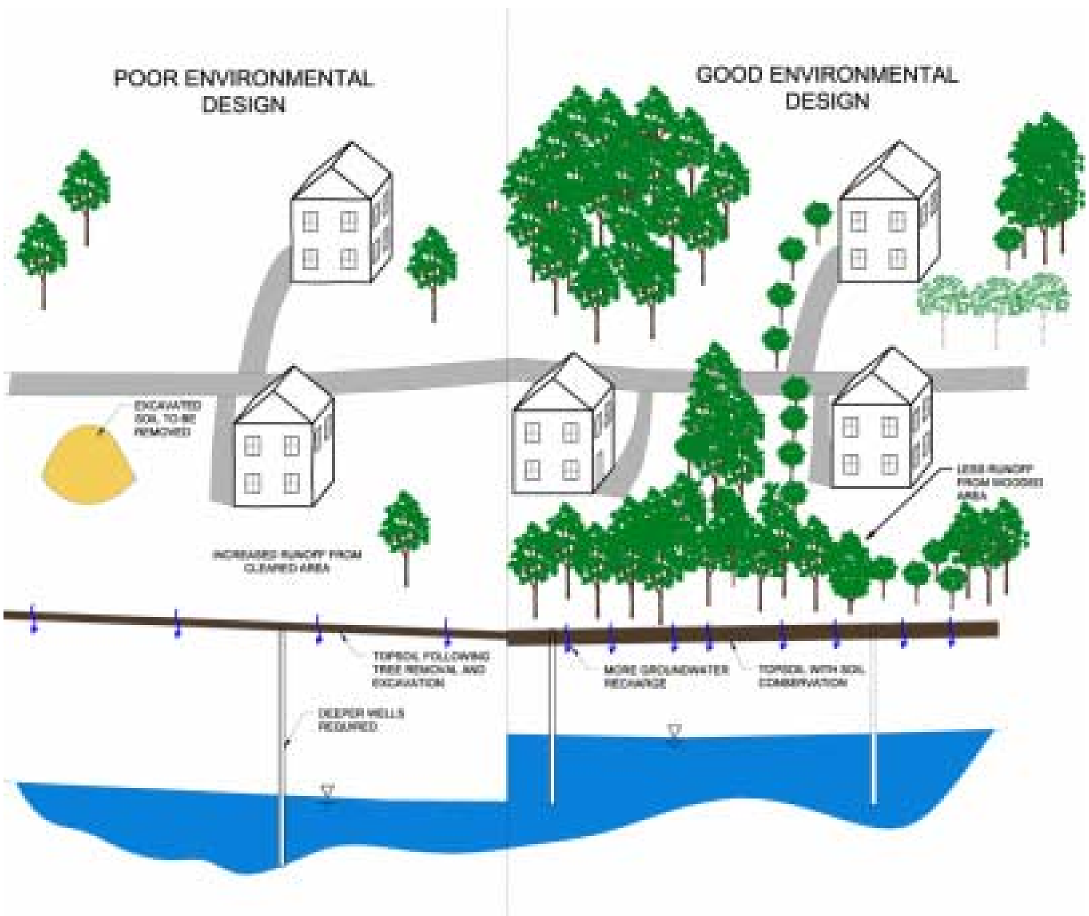
Design Criteria No. 7. Site Clearing

Introduction

Existing vegetation such as mature trees often provide beneficial elements such as aesthetic value, shade, wildlife habitat, noise and visual buffers. In addition, wooded areas slow precipitation and runoff, decreasing erosion and providing higher infiltration rates. Shade from wooded areas cools the ground and air, reducing evaporation of water at the ground level. Removal of topsoil and trees results in increased runoff, higher potential for erosion, decreased infiltration capacities, and decreased habitat. Removal of trees and topsoil also degrades the quality of the planting environment, resulting in landscapes that require high water usage and the application of fertilizers and pesticides, which results in greater environmental impacts and higher costs to the homeowner.

Objectives and Goals

- ❑ Reduce runoff
- ❑ Promote groundwater recharge
- ❑ Preserve existing mature trees and vegetation
- ❑ Preserve existing wildlife habitat



Minimum Standards

The following standards should be followed to promote environmentally friendly designs. Minimizing site clearing will lessen stormwater quantities which will in turn reduce stormwater treatment requirements.

- ❑ The plans shall clearly show the clearing and grading limit lines and stockpile areas. Clearing and grading limit lines shall match.
- ❑ If selective cutting is planned, the applicant shall indicate approximately how much wooded area is proposed to be removed, in total acres and as a percentage of existing. The Planning Board may require more detailed information, such as an inventory of trees to be removed, including the location, size, type, and general health. The Planning Board may also require information on how the area is proposed to be cleared, in order to determine potential impacts to underlying soils and the general area.
- ❑ Existing vegetation to be preserved shall be clearly shown on the plan, and industry standard methods shall be used in the preservation. Areas that will or may require clearing, grading, or regular maintenance, such as utility easements, shall be clearly demarked as such on the plans and differentiated from areas to be preserved in their natural state.
- ❑ If topsoil is to be exported from the site, the applicant shall show how many cubic yards will be removed and the remaining depth of soil left for lawn/landscaped areas.
- ❑ Proposed lawn areas shall be shown along with markings to indicate how many inches of topsoil and its percent organic content will remain in lawn areas (refer to the Town landscaping guidelines).
- ❑ Prior to commencement of construction activity, clearing and grading limit lines shall be staked in the field and checked by the Town.

Regulatory Reference

Many communities have adopted clearing and grading ordinances to reduce the amount of existing vegetation lost to impervious surfaces, compacted soils, and high-maintenance landscapes. The EPA Phase II ruling (12/8/99 Federal Register, page 68760) includes the minimization of clearing and grading and the preservation of existing vegetation as effective measures to preserve infiltration and minimize degradation of water quality. Phase II construction site runoff controls (12/8/99 Federal Register, page 68844) call for limiting construction impacts.

Engineering Criteria

Not applicable.